THE CRUSHED STONE JOURNAL

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The National Crushed Stone Association

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The Effect of Gradation of Crushed Stone on Precentage of Voids

Dr. Baker and Dr. Cattell Will Address Convention

Producers and Manufacturers Meet in New York

Practical Accident Prevention

Research Laboratory Completes First Investigation

NOVEMBER, 1928

National Crushed Stone Association

Twelfth Annual Convention

Hollenden Hotel -- Cleveland, Ohio

January 21, 22, 23 and 24, 1929

Bring Your Superintendents and Operating Men

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The Effect of Gradation of Crushed Stone on Percentage of Voids

BY A. T. GOLDBECK, *Director,*
Bureau of Engineering

ELSEWHERE in this issue there is an announcement from the United States Bureau of Public Roads in which are stated several principles through whose application concrete of greater uniformity and strength is expected than has hitherto been the rule. At least one of these principles is of very vital interest to all producers of crushed stone. This is principle No. 3 calling for, "The scientific grading of coarse aggregate by combination of separate sizes in each batch in the proportions which will produce maximum practicable density."

For the application of this principle the producer must ship his stone, not according to a given gradation extending from the smallest to the largest size as is present-day practice, but, on the other hand, the stone must be separated and shipped in several different sizes, such, for illustration, as ¼ to ¾ in., ¾ to 1½ in. and 1½ to 2½ in. These separate sizes will then be combined at a central proportioning plant and the proper quantities of each will be weighed out for each batch of concrete made. This method of proportioning is intended to produce concrete of greater uniformity and because of the uniformly low voids thus produced in the stone, an increased amount of stone and a decreased amount of mortar is rendered possible, with no sacrifice in strength. A discussion of this entire subject was given at the West Baden Convention of this Association by Mr. R. T. Giles, formerly Materials Engineer for the North Carolina State Highway Commission. Mr. Giles' paper was entitled, "Separate Sizes of Coarse Aggregates for Concrete," and will be found on page 178 of the 1928 Proceedings of the Association.

The fact that the Bureau of Public Roads is encouraging these new methods for concrete proportioning will undoubtedly result in their very wide adoption and, as time goes on, stone producers will be called upon to ship stone in two or more separated sizes to be combined in their proper proportions at the site of the work. The development of a desire for more uniform concrete has been quite apparent and the present action on the part of the Bureau of Public Roads was foreseen by the Bureau of Engineering of the Association as a strong possibility more than a year ago. Consequently, when laboratory facilities were made available, work was immediately started to gain information having a bearing on this subject.

The stone producer is naturally interested in knowing what effect this new method of concrete proportioning will have on his production problems. Principle No. 3 states that the coarse aggregate is to be combined in each batch in those proportions which will produce the maximum practicable density. This, in general, means the combination of the various sizes of stone in such a way that the smallest percentage of voids will result. The purpose of the present investigation is, therefore, to determine what combinations of sizes will give the lowest percentage of voids and also what variation may be made in the proportions of the different sizes without increasing the voids appreciably over the minimum.

Method of Test Procedure

For the purpose of this investigation crushed limestone of a rather good quality was used. It was screened into 6 different sizes as follows:

⅛ - ⅜	inch.
⅜ - ¾	"
¾ - 1	"
1 - 1½	"
1½ - 2	"
2 - 2½	"

The ⅛ to ⅜ in. and ⅜ to ¾ in. sizes were then combined in accordance with a straight line gradation to produce a material ⅛ to ¾ in. in size. The mechanical analysis of this combination is shown as curve No. 66

in Fig. I. This required 40 per cent of ⅛ to ⅜ in. and 60 per cent of ⅜ to ¾ in. sizes.

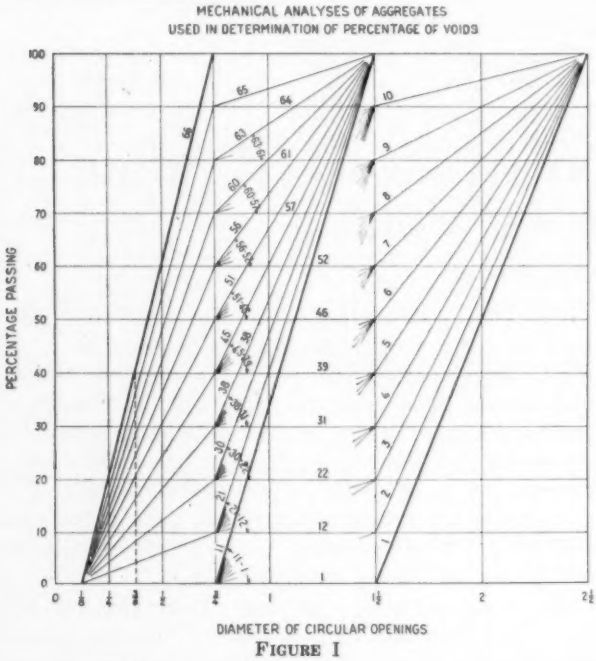

MECHANICAL ANALYSES OF AGGREGATES
USED IN DETERMINATION OF PERCENTAGE OF VOIDS
PERCENTAGE PASSING
DIAMETER OF CIRCULAR OPENINGS

FIGURE I

Similarly the ¾ to 1 in. and the 1 to 1½ in. sizes were combined in the proportions of 33 1/3 per cent of the ¾ to 1 in. and 66 2/3 per cent of the 1 to 1½ in. sizes, thus creating ¾ to 1½ in. material having the straight line gradation shown in curve No. 11 in Fig. I.

The 1½ to 2 in. and 2 to 2½ in. sizes were combined in equal proportions to produce 1½ to 2½ in. material having a straight line gradation shown in curve No. 1, Fig. I. These three sizes, each having a straight line mechanical analysis curve were then combined in 66 different proportions having mechanical analyses all shown in Fig. I. It will be noted that these mechanical analyses curves cover the entire field of possible combinations for these three different sizes. These combinations are also shown in the triaxial diagram of Fig. II. As this diagram is very convenient for showing the effects resulting from the combination of three sizes of stone in different proportions it will be well to explain it briefly.

Each point on the diagram represents a given combination of the three different sizes of materials and the percentage of each size is represented by the perpendicular distance between the point on the diagram and the side of the triangle which serves as the base line for the size under consideration. Thus, point No. 48 in Fig. II represents a material made up of 50 per cent of ⅛ to ¾ in., 20 per cent of ¾ to 1½ in, and 30 per cent of 1½ to 2½ in. size. Similarly, point No. 1 represents 100 per cent of 1½ to 2½ in. and 0 per cent of the other sizes.

From this diagram it will again be seen that the investigation covers the entire range of possible combinations of these three sizes. The ⅛ in. size was chosen as the smallest size to use in this investigation because specifications ordinarily permit a certain percentage to pass the ¼ in. screen and by extending the minimum size down to ⅛ in., the permissible amount passing the ¼ in. screen will approximately be obtained.

The procedure in testing was to weigh out 120 pounds of the combined sizes which were then thoroughly mixed. This mixture was shoveled into a standard American Society for Testing Materials cubic foot measure. (diameter 14.00 in., height 11.23 in.) The tests were made in two ways, first, by loose measurement and, second, by the standard A. S. T. M. rodding method. When the loose measurement tests were made, the material was merely shoveled into the measure and struck off. The rodding test calls for filling the measure one-third full, rodding 25 times with a ⅝ in. by 24 in. bullet-pointed metal rod. This process was repeated three times and the vessel was leveled off and weighed. The weight per cubic foot determination

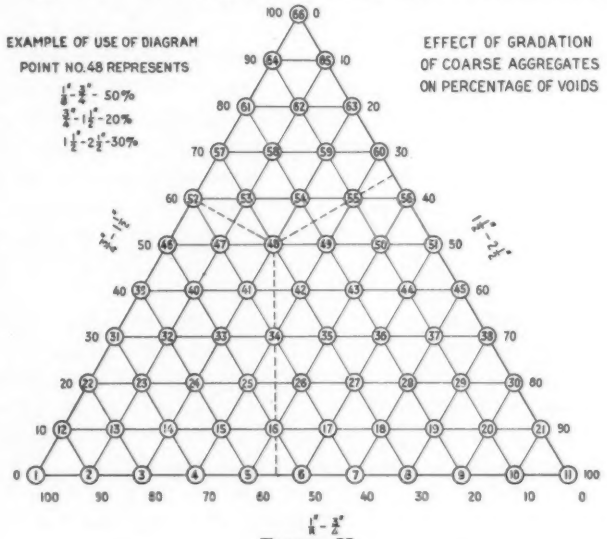


FIGURE II

was repeated twice for each method of filling the measure and the average was obtained for each method. When one determination did not agree with the other within one pound, a third determination was made, but in only a few cases was this necessary. The percent-

age of voids was calculated as follows:

$$\text{Percentage of voids} = 100 \left\{ 1 - \frac{\text{Wt. per cu. ft.}}{\text{Sp. Gr. x } 62.355} \right\}$$

Specific gravity was obtained by the "overflow" method as described in Bulletin 1216 of the U. S. Department of Agriculture. In Table I the weight per

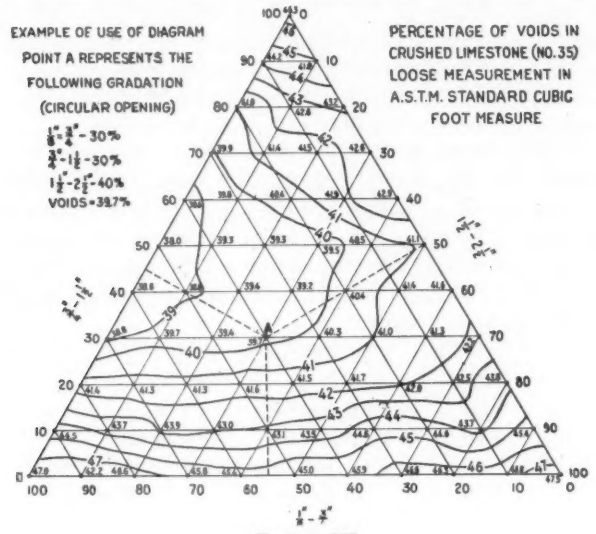

EXAMPLE OF USE OF DIAGRAM
POINT A REPRESENTS THE FOLLOWING GRADATION
(CIRCULAR OPENING)
1" - 3/4" - 30%
3/4" - 1 1/2" - 30%
1 1/2" - 2 1/2" - 40%
VOIDS = 39.7%
PERCENTAGE OF VOIDS IN CRUSHED LIMESTONE (NO. 35) LOOSE MEASUREMENT IN A.S.T.M. STANDARD CUBIC FOOT MEASURE
A
1" - 3/4"
3/4" - 1 1/2"
1 1/2" - 2 1/2"
1/8" - 1/4"
1/4" - 1/2"
1/2" - 1"

FIGURE III

cubic foot and the percentage of voids are shown for both the loose and rodded condition. The results given in this table for voids are plotted in Figs. III and IV on triaxial diagrams. The lines are contour lines of equal voids. The specific gravity of the limestone used in this investigation was 2.75.

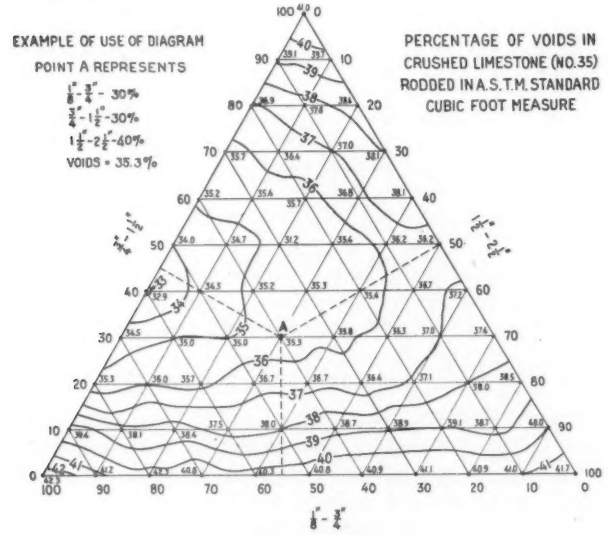

EXAMPLE OF USE OF DIAGRAM
POINT A REPRESENTS
1" - 3/4" - 30%
3/4" - 1 1/2" - 30%
1 1/2" - 2 1/2" - 40%
VOIDS = 38.3%
PERCENTAGE OF VOIDS IN CRUSHED LIMESTONE (NO. 35) RODDED IN A.S.T.M. STANDARD CUBIC FOOT MEASURE
A
1" - 3/4"
3/4" - 1 1/2"
1 1/2" - 2 1/2"
1/8" - 1/4"
1/4" - 1/2"
1/2" - 1"

FIGURE IV

TABLE I

Weights Per Cubic Foot and Percentages of Voids of Crushed Limestone (Specific Gravity=2.75) Graded as Shown in Figures I and II

Grading No.	Loose Wt. per Cu. Ft.	Loose Per cent Solids	Loose Per cent Voids	Rodded Wt. per Cu. Ft.	Rodded Per cent Solids	Rodded Per cent Voids
1	91.0	53.0	47.0	99.25	57.7	42.3
2	90.75	52.8	47.2	101.1	58.8	41.2
3	91.6	53.4	46.6	102.7	59.7	40.3
4	93.0	54.2	45.8	101.8	59.2	40.8
5	93.9	54.6	45.4	102.7	59.7	40.3
6	92.5	53.8	46.2	101.8	59.2	40.8
7	93.0	54.2	45.8	101.7	59.1	40.9
8	91.85	53.4	46.6	101.15	58.9	41.1
9	92.4	53.7	46.3	101.65	59.1	40.9
10	91.4	53.2	46.8	101.45	59.0	41.0
11	90.75	52.7	47.3	100.2	58.3	41.7
12	95.4	55.5	44.5	104.2	60.6	39.4
13	96.8	56.3	43.7	106.5	61.9	38.1
14	98.2	57.1	42.9	105.95	61.6	38.4
15	98.0	57.0	43.0	107.7	62.5	37.5
16	97.85	56.9	43.1	106.6	62.0	38.0
17	97.2	56.5	43.5	105.5	61.3	38.7
18	95.25	55.4	44.6	105.05	61.1	38.9
19	95.35	55.4	44.6	104.85	60.9	39.1
20	96.75	56.3	43.7	105.25	61.3	38.7
21	93.85	54.6	45.4	103.1	60.0	40.0
22	100.85	58.6	41.4	111.15	64.7	35.3
23	101.0	58.7	41.3	110.0	64.0	36.0
24	101.05	58.7	41.3	110.6	64.3	35.7
25	100.3	58.4	41.6	108.85	63.3	36.7
26	100.7	58.5	41.5	109.0	63.4	36.6
27	100.1	58.3	41.7	109.4	63.6	36.4
28	99.75	58.0	42.0	108.1	62.9	37.1
29	98.85	57.5	42.5	106.8	62.0	38.0
30	96.7	56.2	43.8	105.9	61.5	38.5
31	105.2	61.2	38.8	112.7	65.5	34.5
32	103.66	60.3	39.7	111.85	65.0	35.0
33	104.2	60.6	39.4	111.8	65.0	35.0
34	103.75	60.3	39.7	111.1	64.7	35.3
35	102.6	59.7	40.3	110.25	64.2	35.8
36	101.56	59.0	41.0	109.6	63.7	36.3
37	101.0	58.7	41.3	108.25	63.0	37.0
38	99.3	57.8	42.2	107.8	62.6	37.4
39	105.75	61.4	38.6	113.6	66.1	33.9
40	105.15	61.2	38.8	112.95	65.7	34.3
41	104.2	60.6	39.4	111.4	64.8	35.2
42	104.5	60.8	39.2	111.15	64.7	35.3
43	102.55	59.6	40.4	110.95	64.6	35.4
44	100.8	58.6	41.4	108.95	63.3	36.7
45	100.35	58.4	41.6	108.0	62.8	37.2
46	106.76	62.0	38.0	113.3	66.0	34.0
47	104.3	60.7	39.3	112.1	65.3	34.7
48	104.4	60.7	39.3	111.4	64.8	35.2
49	104.05	60.5	39.5	111.0	64.6	35.4
50	102.26	59.5	40.5	109.75	63.8	36.2
51	101.15	58.9	41.1	109.75	63.8	36.2
52	105.5	61.4	38.6	111.6	64.8	35.2
53	103.4	60.2	39.8	111.1	64.6	35.4
54	102.4	59.6	40.4	110.3	64.3	35.7
55	99.85	58.1	41.9	108.55	63.2	36.8
56	98.1	57.1	42.9	106.6	61.9	38.1
57	103.3	60.1	39.9	110.55	64.3	35.7
58	100.85	58.6	41.4	109.35	63.6	36.4
59	100.7	58.5	41.5	108.25	63.0	37.0
60	98.75	57.4	42.6	106.55	61.9	38.1
61	101.45	59.0	41.0	108.5	63.1	36.9
62	98.7	57.4	42.6	107.3	62.4	37.6
63	97.85	56.8	43.2	105.9	61.6	38.4
64	96.0	55.8	44.2	104.7	60.9	39.1
65	94.65	55.0	45.0	103.75	60.3	39.7
66	92.35	53.7	46.3	101.5	59.0	41.0

Discussion of Results

Referring first to Fig. III which represents the voids for the material in a loose condition in the cubic foot measure, it is evident that the lowest percentage of

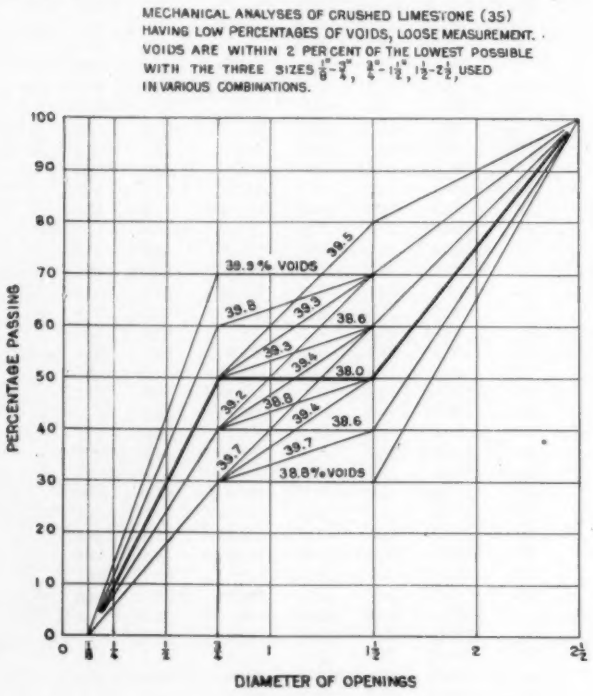

MECHANICAL ANALYSES OF CRUSHED LIMESTONE (35)
HAVING LOW PERCENTAGES OF VOIDS, LOOSE MEASUREMENT.
VOIDS ARE WITHIN 2 PER CENT OF THE LOWEST POSSIBLE
WITH THE THREE SIZES ⅛"-¾", ¾"-1½", 1½-2½, USED
IN VARIOUS COMBINATIONS.
PERCENTAGE PASSING
DIAMETER OF OPENINGS
39.3 % VOIDS
38.8% VOIDS

FIGURE V

voids is obtained with grading No. 46. This material is composed of 50 per cent of ⅛ to ¾ in. size, 0 per cent of ¾ to 1½ in. size and 50 per cent of 1½ to 2½ in. size. There are no intermediate sizes in the mix. The percentage of voids for this grading was 38.0. It can be seen that as more and more of the intermediate size is added to the mixture there is a general tendency toward an increase in the percentage of voids. On the other hand, there is a rather large zone included within the 40 per cent contour which is within 2 per cent of the minimum possible voids.

Obviously if every producer were required to furnish stone graded to have the very minimum of voids on a loose measurement basis, a grading such as in mixture No. 46 or namely—⅛-¾ in., 50%; ¾-1½ in., 0%; 1½-2½ in., 50%, there would be the necessity of disposing of all of the ¾-1½ in. size for some use other than for concrete. This would be a wasteful procedure and would make the production of stone more expensive. On the other hand if a low percentage of voids, a few per cent more than the minimum is permissible and it obviously would have to be permissible to make the general scheme practical and workable, the field is opened up to a reasonable range of sizes. This point is well illustrated in Fig. V in which are plotted the mechanical analyses of mixtures having within 2 per cent higher voids than the minimum. These mixtures are as follows:

⅛-¾ in.	¾-1½ in.	1½-2½ in.
30	0 to 30	70 to 40%
40	0 to 30	60 to 30%
50	0 to 30	50 to 20%
60	0 to 10	40 to 30%
70	0	30%

If the lowest practicable percentage of voids on a "rodded" basis is required and the word "practicable" is interpreted to mean within 2.5% of the minimum possible percentage of voids, a range of gradations which will satisfy the requirements is shown in graphical form as Fig. VI. This possible range of mixtures is seen to be as follows:

⅛-¾ in.	¾-1½ in.	1½-2½ in.
20	0	80
30	0 to 30	70 to 40%
40	0 to 40	60 to 20%
50	0 to 30	50 to 20%
60	0 to 10	40 to 30%

The closer to the absolute minimum percentage of voids required by the specifications, the more restricted

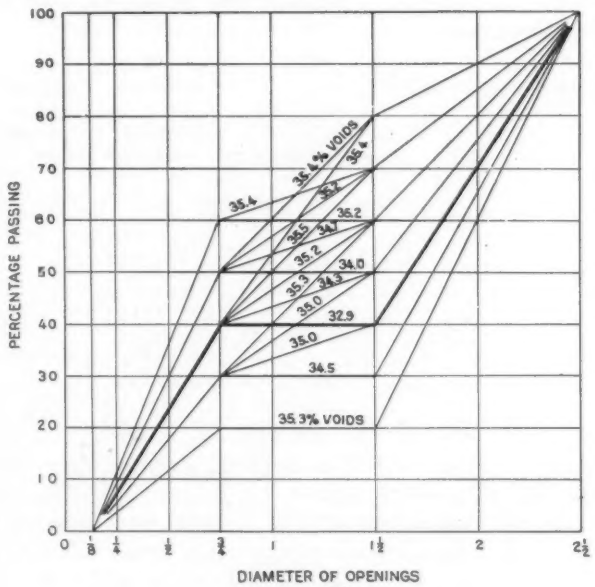

MECHANICAL ANALYSES OF CRUSHED LIMESTONE (35)
HAVING LOW PERCENTAGES OF VOIDS, STANDARD A.S.T.M
RODDED MEASUREMENT.
VOIDS ARE WITHIN 2½ PER CENT OF THE LOWEST POSSIBLE
WITH THE THREE SIZES ⅛"-¾", ¾"-1½", 1½"-2½", USED
IN VARIOUS COMBINATIONS.
PERCENTAGE PASSING
DIAMETER OF OPENINGS
35.3% VOIDS

FIGURE VI

is the range of combination of sizes, but the diagrams in Figs. III and V or IV and VI will show the available combinations necessary to produce any desired percentage of voids.

Applicability of the Diagram

The diagrams in Figs. III, IV, V and VI were obtained for a given kind of limestone having a given characteristic shape. Other stones may be more angular or more rounded and consequently their voids may be somewhat different than those obtained in the present investigation. Nevertheless the same general trend of results should be obtained even though the numerical values are somewhat different and the present should therefore be very useful as a guide in selecting the combinations of sizes which will give the lowest percentages of voids.

The curves are plotted in terms of round openings and if they are desired in terms of square openings the following table, which is applicable only to this particular stone and not necessarily to stones of other shapes, will be useful. Even for the particular stone used the table of sizes is not considered to be other than approximate.

Circular Opening	Approximate Corresponding Square Opening
2½	2¼
1½	1-5/16
1	1-3/16
¾	⅝
½	13/32
⅜	5/16
¼	7/32
⅛	7/64

In the preceding discussion it should not be inferred that the lowest percentage of voids referred to is the absolute minimum that can be obtained but is merely the minimum which was obtained with the three sizes of stone used, each of which had a straight line gradation. This gradation was selected as the most practical because crusher run stone ordinarily has that gradation. No doubt a still lower percentage of voids could be produced by special gradation of the three sizes used but this would be a rather difficult procedure from the operating and producing standpoint and the slight decrease in voids which might thus be obtained would probably not warrant the extra cost involved.

Federal Road Engineers Start Drive For Better Concrete

THE Bureau of Public Roads, United States Department of Agriculture, has begun a drive for better concrete. Declaring that the results of research and tests conducted by the bureau and other agencies in recent years now show that it is possible by applying the theories developed by the experiments to produce concrete of much greater uniformity and increased strength, Chief Thos. H. MacDonald has laid down definite principles by which these results may be obtained.

The bureau's principles, the application of which it will actively encourage, are stated in recent instructions issued by Mr. MacDonald to engineers of the bureau for their guidance in approving future concrete road projects submitted by the States for construction with Federal aid.

Concisely stated the principles are as follows:

1. The abandonment of volumetric proportioning of aggregates and the adoption of proportioning by weights as standard practice. Inundation will be recognized as a permissible alternate method for fine aggregate, but weighing is preferred.
2. Maintenance of the lowest water-cement ratio which, with the particular type, grading, and proportions of aggregate used, and the methods of finishing employed, will produce a workable, dense, and uniform concrete.
3. The scientific grading of coarse aggregate by combination of separated sizes in each batch in the proportions which will produce the maximum practicable density.
4. The abandonment of hand finishing methods in favor of machine finishing.

The State specifications previously approved by the bureau for Federal-aid concrete pavements provide for certain standard proportions of cement, and fine and coarse aggregate. As a result of recent tests the bureau is now convinced that better and more economical concrete may be produced in some instances by increasing the proportion of coarse aggregate previously specified, provided the density and uniformity of the mix are not impaired. It has therefore announced that where adequate engineering control is assured, the coarse aggregate proportions previously approved may be increased if, by combination of separated sizes in each batch, a well graded aggregate is produced and the resulting concrete is dense and uniform, workable by the methods of finishing employed, and of a quality at least equal to that produced by the approved standard mix.

Where concrete in which the proportion of coarse aggregate is increased is placed in competition with concrete proportioned in accordance with the previously approved specifications, the bureau will require that the type of coarse aggregate and the mortar mix in each shall be identical, and that the same maximum limit of water-cement ratio shall govern.

Dr. Hugh P. Baker to Speak at Convention

EVERY crushed stone producer throughout the United States and Canada will, of course, attend the Twelfth Annual Convention of the National Crushed Stone Association at the Hollenden Hotel, Cleveland, January 21 to 24, 1929, and not one of those present will want to miss the get-together luncheon on Monday, January 21, when Dr. Hugh P. Baker, Manager of the Trade Association Department of the Chamber of Commerce of the United States, will talk to us on the timely and interesting subject of, "The Business Man and His Trade Association."

DR. HUGH P. BAKER

Very few men, if any, are better qualified to talk to us along these lines than is Dr. Baker who spent many years in trade association work as Executive Secretary of the American Paper and Pulp Association, a national federated organization, with sixteen affiliated associations.

Before his connection with the American Paper and Pulp Association, Dr. Baker established a national reputation as one of the country's foremost authorities on forestry, largely through his work with the United States Forestry Service with which he was connected for ten years. Later he was professor of forestry at Iowa State College and Penn State College, and then he became Dean of the New York State College of Forestry at Syracuse University.

When the Chamber of Commerce recently established its Trade Association Department, a man of outstanding ability in this field was desired for its head, with the result that Dr. Baker seemed to be the logical person for the position.

This Trade Association department, of which he is now manager, was established for the purpose of co-ordinating the expanding relations of the National Chamber with the more than 400 trade associations in its membership and at the same time to give assistance to the many other industrial groups now laying out their future programs of organization. Trade associations, it is pointed out by Dr. Baker are entering many new fields, opened up by the increasing competition between industrial groups.

"In seeking new and enlarged markets for their members," Dr. Baker explained, "trade groups are more and more interested in organized effort along lines of standardization, resulting in the elimination of excess varieties, uniform cost accounting, helpful statistical information, credit bureau activities, arbitration, etc."

Dr. Baker's departmental activities are also directed towards the promotion of the movement recently initiated by the Chamber looking towards self regulation by business groups, which has as its aim the elimination of economic wastes in every form. Every assistance will be given industry in helping it to do for itself what it needs to have done, particularly in the elimination of trade abuses leading to unfair competition. Where an industry needs outside assistance, the Department will cooperate with the Federal Trade Commission and other governmental agencies.

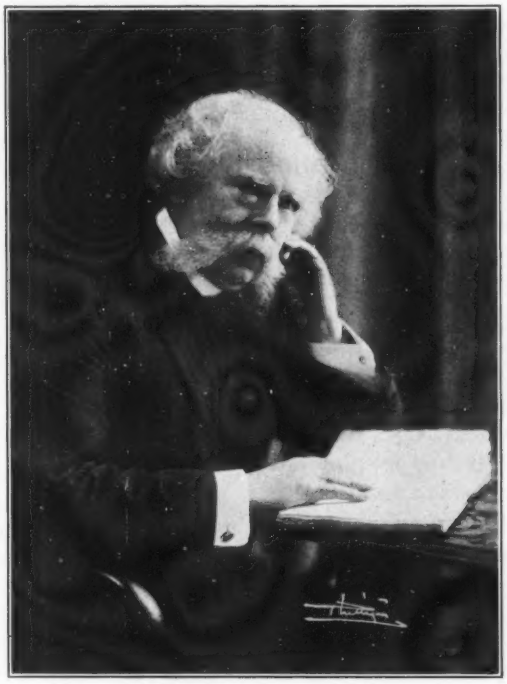
It can readily be seen from the brief outline of Dr. Baker's activities given above that we are assured of a most interesting and valuable talk by him on the occasion of our next annual convention in Cleveland.

All crushed stone producers of the United States and Canada, whether or not members of this Association, are most cordially invited to be with us at Cleveland and we earnestly suggest that you make your plans now to attend this annual foregathering of the industry.

Dr. Cattell to Address Annual Banquet

THE announcement that Dr. Edward James Cattell, "Philadelphia's grand old man," as he has come to be known the country over, will again grace our speaker's table at the Twelfth Annual Banquet of the Association next January in Cleveland, will be received with the warmest enthusiasm by his host of friends and admirers throughout the crushed stone industry.

To those who had the good fortune to attend the Detroit convention Dr. Cattell needs no introduction as who can forget the human and inspirational message which he gave to us at that time under the title of "Getting the Most Out of Life." To those of us, however, who were denied that privilege the following brief biographical sketch should prove most interesting and help us to a fuller appreciation of the message which Dr. Cattell will give to us at our Twelfth Annual Convention.



DR. EDWARD JAMES CATTELL

Edward James Cattell was born in Philadelphia on December 8, a good many years ago. Due to ill health in early life, he was forced to abandon regular studies and live in Washington with a relative then a member of the United States Senate. This enabled him to mingle with men who were making history during the Reconstruction period. His continuing popularity as a speaker with a wide range of audiences is due to the remarkable contacts which Dr. Cattell has had during his long life, lived in many lands.

Traveling with a Senatorial Committee in a special train to the West Coast in the first year that the connection was established between the two oceans, in 1869, gained for him some new experiences. He later became associated with Jay Cook & Company. For twelve years he lived in Europe, there gathering material for a work later published covering financial conditions in every organized government. There he met and knew many of the great men of the past century. He also has some thirty short stories to his credit.

For twenty-five years he was connected with the City Government of Philadelphia, and worked under seven Mayors as their representative at many public functions. A former Mayor described him as "Philadelphia's grand old man and the city's greatest asset." He was also connected with the Chamber of Commerce for a number of years, which brought him in close touch with that organization's work all over the country.

A seasoned speaker, his favorite theme has to do with the philosophy of everyday life, which is grounded on an unshakable belief that we have the best form of government in the world, and that the world is growing better. He is a confirmed optimist, an optimism based upon a personal contact with conditions in all lands.

Dr. Cattell has been listed in "Who's Who in America" for twenty years. Fraternally he is an Honorary and Active member of many organizations. He is an Honorary Member of the National Association of Credit Men; Cotton Spinners of America; a Member of the New York and Philadelphia Credit Association; American Institute of Banking; Honorary Member of the Rotary Club of Philadelphia; Manufacturers' Club; Poor Richard Club; Business Science Club; Pen and Pencil Club; Traffic Club; Sphinx Club of New York; Passenger Association of the United States. He is also an active member of some twenty-five other organizations, including Masonic and other fraternal bodies.

His record in one year showed 75,000 miles of travel, and 1100 addresses within twelve months.

To say that his talk to us at Cleveland will be entertaining would be to do him an injustice. It will be that, of course, but much more, as underlying all of his amusing anecdotes, his keen wit, and refreshing hu-

mor, there is to be found an unshakable faith in human nature and a simple, indestructable philosophy of life, interwoven with an honest and sincere optimism and made all the more interesting by the knowledge that he is recounting to us from his own vast storehouse of personal experiences. To hear Dr. Cattell is a real treat and we will all look forward with pleasurable anticipation to the message which he will have for us at Cleveland next January.

Adoption of 6-Wheel Trucks With Pneumatic Tires Urged to Save Roads

HIGHWAY engineers have always been faced with the problem of producing the greatest mileage of serviceable roads, and have been forced to design them as light as possible, consistent with traffic demands.

To preserve the existing highways and to give economic transportation, the introduction of the six-wheel truck, with a limitation of wheel concentration and pneumatic tires, and not the limitation of gross load, is the solution of the problem, Thos. H. MacDonald, chief of the bureau, recently told members of the Society of Automotive Engineers.

According to investigations of the bureau, all conditions of test being equal, the effect of a six-wheel vehicle on the highways is about one-half that of the four-wheel. This is the first of two important reasons for the six-wheel truck. The other is, that increasing the number of wheels so reduces the load on each wheel as to permit the use of pneumatic tires on the larger sized trucks, which can not be so equipped when supplied with only four wheels. The pneumatic tire reduces the impact of the moving truck and so tends further to protect the highway. The bureau's tests show that the impact of a solid tire exerts a pressure on a pavement two or three times the standing load, while the pressure exerted by the pneumatic tire is only a small percentage above that of the load at rest.

Cooperative highway transport surveys, carried on by the bureau and various State highway departments, have shown conclusively that, for general use, the five-ton, four-wheel truck is today the maximum size required. Its wheel concentrations are within the safe load limit for the modern standard types of rural pavements. But there is a very large mileage that is not safe for loads beyond this. It is to protect this large mileage and at the same time permit the operation of large-capacity trucks wherever desirable that the Federal road chief suggests the six-wheel solution.

Convention Reservations

IT is by no means too early to complete your plans for attending the Twelfth Annual Convention of the Association at the Hollenden Hotel, Cleveland, January 21 to 24, 1929, and we earnestly suggest that you immediately fill out and return the reservation card which was recently sent to you from the Hollenden Hotel. This will insure that you will have just the accommodations which you desire.

Fearing that there might be some difficulty experienced by our delegates in obtaining reservations for Saturday and Sunday due to a possible hold-over from the Road Show, we wrote to Mr. DeWitt, Manager of the Hollenden Hotel, with regard to this and received absolute and unqualified assurance that all delegates would be taken care of as early as Saturday, January 19. Following is the letter received from Mr. DeWitt on this subject and published with his permission:

"Mr. J. R. Boyd, Sec'y,
National Crushed Stone Assn.,
Merchandise Bldg.,
Washington, D. C.

"Dear Mr. Boyd:

"I wish to acknowledge receipt of your kind favor of November 6th and hasten to advise that we are prepared to take care of all reservations for rooms for the duration of the National Crushed Stone Convention in Cleveland in January.

"I also wish to advise that we will be ready to take reservations for your convention as early as Saturday, January 19th, and that we will be able to accommodate all who want to come on Sunday, January 20th.

"There seems to be a false rumor about that the hotel will be crowded even after the Road Show and I would like to correct this right now. There is positively no reason for anyone to feel that the hotel will not be able to take care of their wants and I will greatly appreciate your advising your members to this effect.

"If they will direct their reservations to my office. you may assure them positively that they will find their accommodations ready for them upon their arrival at The Hollenden.

"I will very much appreciate your mentioning this fact in your next issue of the *Journal.*

"With kindest personal regards, I am,
Cordially yours,"
(Signed) THEO. DEWITT,
General Manager.

New York Producers and Manufacturers' Division Meet at New York City

THE Manufacturers' Division of the National Crushed Stone Association held its annual dinner meeting at the Hotel Pennslyvania, New York City, on October 26, and following a custom of many years' standing, the members of the Executive Committee of the National Association who had met in the morning were the guests of the Division at the dinner. What proved to be a most welcome and highly successful innovation, however, was the holding of the regular monthly meeting of the New York State Crushed Stone Association at New York City on the same day. All members of the New York Association were invited to be present at the dinner and that they attended practically in a body is attested to by the unusually large attendance of eighty-two. In this connection it is interesting to note that exclusive of the members of the Executive Committee and New York Association who were present, there were fifty-four manufacturers' representatives in attendance which considerably exceeded the mark set at any previous dinner.

The principal topic for discusssion at the meeting following the dinner was the arrangements for the Manufacturers' Division Exposition to be held at the Twelfth Annual Convention of the Association at Cleveland, Ohio, January 21 to 24, 1929.

C. B. Andrews, Chairman of the Division and presiding officer of the meeting, and J. R. Boyd, Secretary, stated briefly the arrangements for the forthcoming Exposition and announced that the cost of booth space would be $50.00 per booth. President Graves, the members of the Executive Committee, and others made short addresses. Living up to the reputation which he has established on similar occasions in the past, Gordon Buchanan, who had charge of the arrangements, left nothing to be desired.

New York Association Meeting

The New York State Crushed Stone Association held its regular monthly meeting at the Hotel Pennsylvania during the morning. George E. Schafer, President of the Association, presided.

The most important subject brought up related to the proposed changes in the state lien laws with practically everyone present contributing to the discussion.

George B. Holderer, mining engineer, Air Reduction Sales Company, New York City, and Gilbert H. Montague, member of the New York Bar, were the speakers at the noon luncheon which concluded the meeting.

Mr. Holderer gave a most interesting and instructive talk, describing the experiment of the Michigan Limestone and Chemical Company, the largest quarry operators in the world, with the new liquid oxygen explosive (L. O. X.).

Mr. Montague, whom we will all recall as having addressed us so interestingly at West Baden last January, discussed the always pertinent subject, "Recent Steps in Business Self-Government," and has very kindly condensed his remarks for publication, as follows:

"Never has the Government gone so far as during the past year in its encouragement, support and enforcement of business self-government by business and trade groups.

"One industry after another, in trade conferences called by the Federal Trade Commission, is today adopting rules for eliminating trade abuses, which rules are all registered with the Commission, and are daily being enforced with all the strength of the Commission's authority behind them.

"What this means, in upbuilding the tone and morale of American business, can hardly be over-estimated.

"Business ethics are created, not by laws, but by the opinion of business men.

"All the laws in Christendom are powerless to raise the business standards of a single industry above the level reached by the preponderance of public opinion among the reasonable and fair-minded men in that industry.

"This truth most people entirely overlook, when they are pushing new legislation to improve business standards.

"Business self-government, simply because it is self-government, and not government imposed from an outside authority, is creating for business higher standards and more rigorous enforcement than have ever been attained either by the governmental authorities or the courts.

"Forward-looking leaders in the business world now recognize in trade associations a long awaited opportunity for business men, through methods of trade

(*Continued* on page 20)

General Crushed Stone Company Receives Safety Award

ON October 9, at White Haven, Pennsylvania, an impressive ceremony marked the presentation of *The Explosives Engineer* award to the member of the National Crushed Stone Association having the lowest accident-severity rate in the 1927 National Safety competition. The winner, as announced in a previous issue of the Journal, was the White Haven quarry of the General Crushed Stone Company.

The General Safety Committee (standing) and the Plant Safety Committee.

It seems particularly appropriate that a plant of the General Crushed Stone Company should have won *The Explosives Engineer* trophy, awarded to the member of the National Crushed Stone Association obtaining the best record in the 1927 National Safety Competition, as that company has taken a deep and active interest in accident prevention work for a number of years. John Rice, President and Otho M. Graves, Vice-President and General Manager, have always evidenced a keen interest in safety matters and the organization is most fortunate in receiving such whole-hearted and sympathetic cooperation from its executive staff. It will be remembered that Mr. Graves as President of the National Crushed Stone Association appointed its first committee on Welfare and Safety whose purpose it was to study accident prevention throughout the crushed stone industry and make such recommendations as would be helpful in eliminating accidents.

Mr. N. S. Greensfelder, Editor of *The Explosives Engineer*, presented the award to P. H. Jacoby, Superintendent of the winning quarry. In presenting the trophy, Mr. Greensfelder stressed the value of organized safety education, congratulated the winners on their remarkable safety record and wished them Godspeed in their efforts for the year 1928.

John Rice, President of the General Crushed Stone Company, in a brief address, told how safety education was not only a humane but an economic movement, how by reducing accidents the insurance rates had been lowered, workmen's compensation and accident benefits were reduced to a very low level and how the home life of the workers had reached a high plane heretofore impossible. Otho M. Graves, Vice-President and General Manager, General Crushed Stone Company; H. F. Yotter, Insurance Supervisor, General Crushed Stone Company; T. J. Quigley, Chief, Bureau of Pits and Quarries, Commonwealth of Pennsylvania; and E. S. Chapin, Engineer, Independence Bureau, also addressed the assembled men.

The plant safety committee at the White Haven quarry consists of the following: P. H. Jacoby, Superintendent, Elmer P. Wheeler, John J. Park, William Schaffer, Jr., John Bensch and Edward Kulp. Much credit is due these gentlemen for their accident prevention work.

The General Safety Committee whose duty is to meet, as the occasion demands, for discussing the various problems that arise and to review the accident prevention work already put into operation consists of the following: Otho M. Graves, Vice-President and General Manager, H. F. Yotter, Insurance Supervisor, John Rice, Jr., Purchasing Agent, Barry Rex, Amiesite Sales Manager, and Frank S. Jones, Production Manager.

N. S. Greensfelder, right, editor, The Explosives Engineer, presenting plaque to P. H. Jacoby, Superintendent of White Haven Quarry of General Crushed Stone Co.

Practical Accident Prevention*

By J. R. Davis,
Assistant to Vice President in Charge of Operations
United States Gypsum Company

LAST year at the A. B. C. Session of the Safety Congress, which many of you doubtless attended, Mr. Colville, Manager of the Insurance Department of our Company, read a letter written by Mr. Knode, our Vice President, announcing a new plan of accident prevention. The plan was, in substance, that the United States Gypsum Company would cut the red tape of accident prevention; that we would stop *asking* our men to work safely, and *demand* that they work safely, or in other words, that we would become "hard boiled" in the matter of safety.

The reaction to this letter, by those attending the A. B. C. Session, was varied. One or two of those present reacted favorably, but the majority felt that the plan was too drastic, too "hard boiled," to achieve the results desired. The plan, however, was put into effect; and today I want to discuss the reasoning that led to its adoption, in the hope that our experience may be of benefit to others, who find themselves in a similar situation.

A year and a half ago the United States Gypsum Company was practicing all the conventional ideas of accident prevention. We had safety committees, gave safety prizes, gave safety dinners, conducted no-accident campaigns, held safety rallies, etc. Despite these efforts we were confronted with accident costs higher than we felt necessary, and an alarming list of fatalities. Mr. Knode, our Vice President, was the only one among us who saw clearly the cause and the remedy, and it was his clarity of vision that developed the plan announced at the A. B. C. Meeting last Autumn.

This plan has produced results; and I expect as I have said, to show you that sound reasoning lead to its adoption, and that, in our case at least, the decision to adopt it was the right one.

Accident Prevention Like Life

Accident prevention, looked at in one way, is like life itself. Some succeed in life; others do not. Some succeed in preventing accidents; others do not. The sound preparation for success in life is education, acquired either in institutions of higher learning or in the school of experience, and similarly the basis of accident prevention is education. Education by itself does not bring success. But education, plus application, plus the desire for success, inevitably brings success. The same chain, education, effort and desire, prevents accidents. In other words, education as to the causes of accidents and the manner in which accidents can be avoided, plus the application of that education, plus the desire to prevent accidents, brings success in accident prevention.

It appears to us of the United States Gypsum Company that the greater part of the safety work we have done in the past has been educational. Now we are applying the education. And we make the utilization of the education compulsory. No longer do we tell employes that they *should* wear goggles, or that they *should* shut down machinery that is to be oiled, because education and experience have taught them that these things *should* be done. We tell employes that they *must* wear goggles, and that they *must* shut down machinery that is to be oiled; that if they fail to do these things their jobs will be in jeopardy.

And to some of you here today that attitude may seem an about-face from me, for a year ago I told you that safety primarily is a sales problem, that the idea of safety must be *sold* to employees. I still believe that the idea of safety must be sold or, in other words, I believe that employes must be educated to the importance of safety. Our experience however indicated that education, when treated as a sales problem, reached only 90 to 95% of the men and was voluntarily accepted by them but it was the other 5 or 10% who simply would not accept it that was ruining our accident record and raising our costs. For this reason we changed our policy to one of compulsion and demand that they apply their knowledge of safety or suffer the consequences.

Application of a Common Principle

The statements I have made may sound radical. Actually they are not. All of you gentlemen apply the principle described in your everyday affairs. Experience has taught you, for example, that a crusher must be started before rock is fed into it. Suppose one of your workmen dumped rock into a crusher and then tried to start it. The result would be one or two hours loss of operating time, due to the necessity of cleaning out the plug-up. What would you do to such a man? You would reprimand him or fire him on the spot.

*Presented before the Quarry Section at the Seventeenth Annual Safety Congress, New York City, October 2, 1928.

Suppose again that you had planned a shot in your quarry, and had left instructions as to how the shot should be loaded. Suppose the shot to be a failure that delayed operations and piled up expense. In investigating the cause of the poor shot you find that it had been loaded contrary to your instructions, because some person thought it didn't make much difference how the charge was placed. What would happen to that person? He'd be severely reprimanded or fired; and neither reprimand or discharge would strike you as particularly radical.

But if some workman violates a safety rule, and is laid off, or fired, in consequence, the action is considered radical, or "hard boiled." Why should it be? It is no more than the application of the same discipline to the matter of safety as is applied to costs, quality and numbers of other things connected with manufacturing. You discharge a workman who wastes your money or time. Certainly a careless workman wastes both. And certainly a workman discharged for violating a safety rule is an example to other workmen.

Now let's see if comparable discipline is applied in your own home—and applied to a problem of domestic safety. The example I am to cite will not be within the personal experience of all of you gentlemen, but it will be near enough to personal experience to bring home my point.

Let's say each of you lives near a river; and let's say that each of you has a small son. The river you regard as dangerous. The son you regard as precious. On a certain night the young man comes home with wet hair. You ask him how he got his hair wet. He tries to evade a direct answer, but you finally drag out of him the confession that he has been swimming in the river. Immediately you are alarmed for his safety. By reason and persuasion you attempt to convince him that the river is dangerous, and that he should not go swimming in it again. A week passes, and again you discover your son with wet hair, and again he confesses, reluctantly, that he has been swimming in the river. You repeat your arguments; he promises to respect your wishes. Another week passes, and once more you find the boy with wet hair, and once more you extract the confession that he has been swimming in the river. What do you do? Do you again reason with the boy? Hardly. Convinced that reason and persuasion are of no service, you take the boy to the wood shed; and there you discipline him —with a strap.

Are you acting differently then, than we act when we discharge a man who violates a rule of safety? Are you dispensing a different brand of justice?

After all, accident prevention simply is good business, as discipline is good business. And the plant wherein discipline is maintained not only will be a safe plant, so far as accidents are concerned, but in virtually every instance will be a plant wherein manufacturing costs are low, quality is high, and "housekeeping" is efficient.

What Are Accident Costs?

Webster defines mining as "the art of extracting ore from the ground at a profit." Quarrying is open pit mining. If we are good miners, market conditions being favorable, we make a profit, largely by keeping our costs down. Accidents are an item of cost; and if we attempt to operate without an accurate knowledge of the cost of accidents, we fail, in part, at our jobs.

But what are accident costs? Are they solely the money paid in premiums for compensation insurance? We don't think so. In our case we compute costs of accidents, not only by the premiums we pay, but by money spent on hospital bills, doctor bills and compensation actually paid to the injured man or his family or in other words to actual cost of the accident. These figures we compare with our past costs in the same manner that we compare operating expenses and profits with the past. And it was this comparison of accident costs, on the basis just described, that led us to abandon the more sentimental policy of accident prevention by wheedling and persuasion, and to substitute for it the clean-cut policy of individual responsibility of each workman to observe the safety rules that we make.

And I might point out, that if you find compensation rates high, the best way to force them lower is to reduce the number of accidents in your plants.

Results of the New Plan

As I have already said, the plan of making the individual workman responsible for his own safety has been in operation for approximately a year. You want to know the results, of course. Before I give them to you, however, I am going to read to you a letter, written by one of our Works Managers who was quick to grasp the significance of the plan. This man has had much experience in mill operation and his point of view is more practical than literary. So disregard the literary style and heed the meat of his remarks. Here is what he said:

Grand Rapids, Michigan

MR. O. M. KNODE,
Vice President.

I have your letter setting forth our safety record for the year to date. This report is disheartening, and after all you have done to promote safety, the facts must be a keen disappointment to you.

I have read the letter many times, and in the following letter I have tried to analyze it from two viewpoints. Though I may not have succeeded in my analysis, I have, at least, set forth my true thoughts, and expressed my attitude.

Under the present plan we try to promote safety by appealing to our workmen, the strongest note in this appeal being that we are seeking safety for them. We invite them to serve on our safety committees, ask their advice as to how we can better conditions, try by means of bulletins, movies, literature, and "silver-tongued" orators to show them the errors of their ways, and the heart breaks, wants, and suffering that is caused by accidents.

We make personal appeals to our workmen, begging them for the sake of their loved ones to work carefully and not get hurt, and as a net result of the time and money spent we have a mounting accident cost, and workmen whom we have not only failed to convince that safety paid dividends, but that we were even sincere in our purpose.

Now, it is very evident that we have failed. Why? I can only give my opinion, and that is, that there has been too much division of authority, or rather, no authority, and too many uninterested men on our safety committees.

The plant managers put safety work up to safety supervisors, who pass it on to the different committees and foremen. The safety supervisors have their routine inspections and meetings, and consider the work done when they have turned in the regular number of suggestions concerning guards and defective equipment, should they be able to know what defective equipment was.

These reports are all nicely typewritten, and presented to the works managers. And as there is a lot of them, and as he has a number of trusted employes on the committees, he assumes that his plant is as safe as a nursery, and that all his employes are true disciples of safety. Then there is an accident, but no one is to blame. The required number of men have been on the committees. The inspections have all been made on the day and date set. Meetings have all been called to order at the specified time. The minutes and records are all complete. The safety supervisors have done their duty in a routine manner, and have complied with all rules as set forth in the safety bulletin governing the Plant Safety organization. This done why should they be to blame for an accident. They all are sorry of course, and express their sympathy in different ways. By sending flowers, or, if necessary, by taking up a collection. This done, their interest, which was first aroused at the time of the accident, stops, and the accident is something that just happened, and happened because we had a safety man in the office reading up on improved safety methods written by a man also sitting in an office; because we had a committee of foremen who served on the committee only because they had to and whose minds were more concerned regarding the quality of a certain product, or the production of a certain machine than they were concerning the inspection they were making, and whose idea of safety was to run in as many suggestions as possible regardless of their value; because we had a committee of workmen, who, believing that we were not sincere in our efforts, were not sincere themselves, but as they had to do something, turned in a lot of recommendations, the chief value of which was to take up the stenographer's time in writing them. This being the cause, the remedy would be:

First, a safety supervisor who knew what he was required to do, and had the authority to do it. In a small plant this would be the superintendent, and in a large plant the assistant works manager, for it is just as essential to have some one with authority in charge of safety as it is to have some one with authority in charge of quality or production. In fact the three are so closely related that they should come under one head.

This supervisor, whoever he would be, would have as his only assistant a man who would keep records necessary to carry on the work. These records should be a true statement of conditions, and not records that lead to the belief that we were making progress when we were not; and should include records of the men, who as far as the workmen are concerned, are the company: the department heads, foremen and the key men on whom the success of the safety movement depends. These men were chosen as foremen, etc., because they were above the average and able to lead, and do lead in everything but safety. In safety however, we have a division of authority, and, as stated before, a safety supervisor with ideals that do not fit conditions, a foremen's committee, which knowing that they are not held responsible, have no interest other than to get their inspections done and to get back to the job for which they are held responsible, and a workmen's committee, the main function of which is to clutter up the joint meeting with numerous and worthless suggestions, but which must be taken up and disposed of in a manner which will not offend them. It is true that it is a part of this committee's duties to interest their fellow workmen in the safety-first idea, and to caution them whenever they resort to unsafe or unsanitary practices. But it is not done. And as I see it, it can not be done. When men are not sincere they can not be convincing.

Second, as they have no authority they can only suggest.

Third, as the workman lifting on one end of a board considers himself just as good as the man on the other end, and will resent anything he may say regarding his habits or practices, many workmen resent safety warnings.

Fourth, the average workman, whether he be a high priced mechanic or a common laborer, has no use for tale bearers, and though he may know of unsafe practices will not report them. The only way such practices can be found out is through the foreman, and as he would be responsible for the safe operation of his department, he would have authority to see that unsafe practices or habits be stopped, or he could dismiss the workmen, and when he did, it would be his duty to talk to the man and impress on him that he was being dismissed because he had persisted in doing what the company considered as detrimental to its interests.

I would, in this way, show our workmen that safety paid, not only by eliminating pain, want, and suffering caused by accidents, but also pain, want, and suffering caused by the careless workmen having no place in industry.

Safety is an ideal worthy of our best efforts, and it would be sublime if it could be obtained by ideal methods. But if this is not possible, let us strip it of its glamour and make it just what it should be, a cold business proposition, in which all sentiment is left out.

This will require work by plant managers, work by the department heads and foremen. And the measure of success obtained will be in proportion to their efforts. To me this does

not appear as added work, but an opportunity to show you that we can and will, if it is within our power to do it, attain your safety ideal.

(Signed) F. O. Gotch,
Works Manager.

This was the response of a practical operator to Mr. Knode's plan. And the results of his attitude immediately were apparent in his plant. Others, however, did not grasp the vitality of the plan as quickly as he did, and were slow to put it into operation. But August, 1928, the busiest month we have ever had, and one in which we employed many new men, was one of the best months, from the viewpoint of safety, that the United States Gypsum Company has had. And with your permission, I will read details of our August safety record.

		Year to Date	
	August 1928	*1928*	*1927*
Fatal	None	5	6
Permanent Total	None	1	2
Disability one or more days	16	111	127
Total reportable	65	420	473

In order to better apply the principle of individual responsibility for accidents, we now analyze all accidents by causes, dividing them into personal and impersonal classifications. We further break them down so that the real cause of each accident may be known, and the proper remedies to prevent repetition may be applied. I have a few copies of our method of analysis if anyone wishes one.

In addition to this we require our foreman to send in a complete report of each accident. This report sets forth the circumstances under which the accident occurred, leads up to a conclusion as to the real cause of the accident, and requires a statement as to what action is being taken to prevent a repetition of the accident. The application of our method of analysis to our August accidents gives us the following classifications of causes.

Personal

1.—Supervisor	1
Incomplete Instructions	
2.—Worker	
A—Mental Deficiency—	
Ignorance	1
Poor Judgment	6
B—Mental Laxity	
Inattention	40
Non-cooperation—	
(disobedience of rules)	2
C—Physical Defect—	
Weakness	1
D—Unsafe Practice—	
Clothing (gloves)	1
Haste	2
Short Cuts	3

The point most to be observed in the analysis just presented is that forty out of fifty-seven accidents were due to inattention or carelessness. Accidents resulting from these causes are the ones we are constantly striving to overcome, for it is these types of accidents that are most frequent and least necessary. It may occur to you that our August record does not show, in preventing these types of accidents success comparable to the enthusiasm with which I have presented our new plan of accident prevention to you. In our plants, however, the percentage of accidents resulting from inattention and carelessness is declining sufficiently to convince us that we are on the right track; to convince us that so soon as all factors concerned in the operation of the plan are thoroughly understood the results will far outstrip anything that we have accomplished in accident prevention in the past.

Chairman Stull Calls Meeting of Research Committee

THE Research Committee of the Association on call of John W. Stull, Chairman, will hold its second meeting of the year at the Cosmos Club, Washington, D. C., on Friday, December 14. The Committee will assemble promptly at 1:00 P. M. for luncheon which will be followed by the business session.

Many members of the Association make it a point to attend the annual meeting in Washington of the Highway Research Board of the National Research Council which this year will be in session on December 13 and 14 and Chairman Stull wishes to extend to all of our members who will be in Washington at that time a most cordial invitation to meet with his committee.

Consideration will be given to the annual report of the Committee to be presented at Cleveland as well as to other important matters and all who can possibly do so are urged to attend.

Your Road Bill and Future Generations*

IF it were not for the apathy on the part of the voters and the general lack of knowledge regarding the finances of local, state and national governments, the issuance of bonds for the purpose of building roads instead of the "pay-as-you-go" plan, such as taxation of gasoline for the purpose of raising revenues, probably would be more desirable from an economic standpoint. Over a period of years the cost would possibly work out to be about the same. The pay-as-you-go advocates usually forget to charge interest on the amount of money invested annually in roads year after year, whereas they are vociferous in pointing out the way the interest accrues on the bonds issued for road building purposes.

There would come a time, theoretically at least, in which the two methods would balance. In other words the pay-as-you-go plan would run for a period and the interest would commence to accrue on the investment. Likewise, after running for a period on the bond plan the principal on the bonds would be reduced to a point where the interest would be about equal to what we would have paid on our investment made through the pay-as-you-go system. However, we cannot get away from the fact that there have been rare but very regrettable examples of issuance of bonds and expenditures of the funds derived therefrom in the most insane manner.

Know Before You Vote

It certainly behooves every voter to compare his tax rate with those of other communities and decide for himself whether he thinks the issuance of road bonds will raise his rate too high and not only his rate but pass on to posterity an unwieldy burden of taxation. This fall voters of six states will be asked to vote for or against the issuance of $330,000,000 in highway bonds for funds to be used for immediate completion of state highway systems. And in addition, in five or six other states the proposal is up for the issuance of $500,000,000 in bonds with which to expedite the completion of state highway systems.

Commenting upon this situation, Roy D. Chapin, Chairman of the Highway Committee of the National Automobile Chamber of Commerce says:

"With the exception of California's grade crossing bonds, all the bonds which it is proposed to issue will be financed from motor vehicle registration fees and gasoline taxes. In West Virginia authority will be granted to levy a general tax if necessary, but first resort will be had to the motor vehicle fees and gasoline taxes.

Greatest Progress in South

"The other states where there is active agitation at the present time for the issuance of highway bonds are all located in the south. Texas, largest of all, is also talking in terms of a $300,000,000 issue with which to redeem county bonds used for state highways and to further extend the state system; Georgia would issue $150,000,000 over a period of years for the retirement of county bonds and completion of a state road system. Mississippi is moving toward a $50,000,000 issue and Louisiana a $30,000,000, while Alabama proposes an issue of $25,000,000. These bonds would also be financed from motor vehicle taxation, the bonds being issued over a period of years as the income from motor vehicle taxation rises and stabilizes.

"A study of the bond proposals actually on the ballot and those projected, evidences a desire on the part of state officials to lighten the burden of counties and local tax groups who have issued bonds and otherwise taxed themselves to build roads which are on the main state system and indispensible to the state as a whole.

Real 'Pay-as-You-Go' Method

"Strong sentiment seems to prevail too as to the advisability of saving 5 to 10 years in the completion of the state system by means of the bond method. The result is actually a 'pay-as-you-go' plan, but with the roads actually in service. The experience of states like North Carolina where bonds were issued to pay for the state system contrasts most favorably with other states where the fallacious doctrine of 'pay-as-you-go' in the ordinary sense still maintains. In those instances the motorist too often pays without going.

"North Carolina, for instance, has not only been retiring her bonds from motor vehicle taxation, but as rapidly building up a surplus which is to be devoted to the building of laterals and the further extension of the state system. In the meantime the users of the road have saved in operation costs more than the cost of the bonds, yet have done so without a burdensome increase in such taxation."

*From the November, 1928, issue of *The United States Banker.*

Highway Research Board Will Hold Annual Meeting December 13 and 14

ANNOUNCEMENT was recently made by Roy W. Crum, Director, that the Eighth Annual Meeting of the Highway Research Board will be held December 13 and 14, 1928, at the National Academy of Sciences and National Research Council Building, B and 21st Streets, Washington, D. C. The statement continues as follows:

"This will be an open meeting and everyone interested in the development of the construction and use of highways is invited to attend.

"It is our hope this year that the meetings will be unusually interesting. To this end the committees are preparing their most interesting topics for full platform presentation and ample time will be allowed for discussion from the floor.

"The full reports will include much valuable information which cannot be presented orally. This will be published in the Proceedings, which we expect to have ready for distribution early in the new year.

"The meeting will cover two days, with the annual Highway Research Dinner on the evening of December 13.

"We repeat, everyone interested is invited."

The following committee reports which will be presented before the meeting should be of particular interest to crushed stone producers and consequently brief descriptions of them are quoted from Mr. Crum's announcement.

Structural Design

A. T. GOLDBECK, *Chairman*

"It will be the aim of the committee to present its report in such a manner that the data will be immediately available to the practicing engineer. In the past the various fundamental principles which have been established have been reported by the committee with supporting data. It is the aim this year to apply those principles to practical design, giving numerical examples wherever feasible. It is hoped to present practical methods based upon sound research for taking care of unusual drainage and other subgrade conditions, as well as methods for design of both rigid and non-rigid pavements, covering cross section, reinforcing, joints, dowel spacing, edge strengthening, and design of secondary roads.

"Reports on new developments in finishing bituminous surfaces, the Bouyoucos hydrometer in making mechanical analyses of soils, settlement in peat marshes, and factors to be considered in the correlation of soil and pavement conditions will be made. Individual portions of the report will be presented by H. M. Westergaard, V. R. Burton and Samuel Eckels."

Character and Use of Road Materials

H. S. MATTIMORE, *Chairman*

"Two principal topics will be discussed. A report of the extensive research work upon which the Pennsylvania design for guard rail is based will be made by Mr. Mattimore and a discussion of the properties of bituminous materials for surface treatments is in preparation by Messrs. Emmons, Lang, and J. E. Myers."

Maintenance

G. C. DILLMAN, *Chairman*

"The report will discuss briefly and bring up to date the topics covered during the past few years, making definite recommendations wherever possible. Among the list of subjects are: Crack Fillers for Concrete Pavements; Dust Prevention and Surface Treatment of Gravel; Roads Including Sizes of Mulch Gravel; Bituminous Wearing Surfaces for Gravel Roads; Rythmic Corrugations in Gravel Roads; Maintenance Machinery for Gravel Roads; Earth Roads Oiling; Bituminous Treatment of Earth, Sand-clay and Top-soil Roads; Snow Removal—Equipment and Drift Prevention; Guide, Caution and Danger Signs; Maintenance Accounting; Maintenance Costs as Affected by the Life of the Road; Maintenance Costs as Affected by Type of Pavement and Amount of Traffic; Coverings for Poorly Constructed and Disintegrating Concrete Pavements; Maintenance of Concrete Pavements; Annual Reduction in Thickness of Gravel Roads Under Different Traffic and Effect of Dust Palliatives; Berm Maintenance; Cause and Cure of Frost Boils; Bridge Maintenance, Including Painting and Reflooring."

Low Cost Road Report

"The final report of the Low Cost Road Investigation by C. N. Conner is now in the print shop. It should be ready for distribution by the middle of November. Copies will be sent free to our usual mailing list of people connected with our work, and to the subscribers to the Seventh Annual Proceedings."

Rock-Dusting of Coal Mines Urged to Reduce Winter Hazard

IN a statement issued November 15 by Scott Turner, Director of the Bureau of Mines, U. S. Department of Commerce, coal mine operators are urged to give particular consideration to mining hazards which accompany cold weather. The complete text of the statement follows:

With the approach of cold weather, and the consequent working of coal mines to full capacity, it is urgent that bituminous mine operators review their safety problems, with special attention to rock-dusting as a means of preventing coal-dust explosions.

Cold Increases Hazzards

At this season, coal-mine passage ways tend to become dry, with resultant dangerous accumulations of coal-dust. Rock-dusting is a proven method of preventing coal-dust explosions, and mine operators who have not yet adopted rock-dusting should by all means do so, both as a moral obligation and as a form of business insurance in the protection of life and prevention of destruction of property in their mines.

Suggested Precautions

The principal recommendations call for rock-dusting in all passages or entries and in all rooms and pillar workings, to within 40 feet of the face, the rock-dust to cover top, floor, sides, and timber. As additional defense, Mine Safety Decision No. 5 of the Bureau of Mines also recommends "that rock-dust barriers be used to sectionalize the mine; these should not be regarded as a substitute for generalized rock-dusting."

As concerns the size of particles of rock-dust, all should pass through a 20-mesh sieve, and 50 per cent or more should pass through a 200 mesh sieve; also the rock-dust should not contain more than 25 per cent of free silica. A white dust like limestone or gypsum is preferable, as such dusts increase illumination and make it easier to discern subsequent depositions of coal-dust.

The most important specification states that the percentage of inert or incombustible material in the mine dust in every part of the mine shall be maintained at least at 55 per cent or more, and in parts of the mine where methane is found in the ventilating current, the amount of incombustible material shall be raised 10 per cent for each 1 per cent of gas.

Weekly Inspection Urged

It has been found that one of the most important aids to effective rock-dusting is the systematic taking of samples of the mine dust at least once a week, analyzing or determining by a volumeter the noncombustible content, and recording same in a record-book to insure that rock-dusting is being properly done. Another excellent practice towards maintaining rock-dusted surfaces in safe condition is the use of sprays on machine cutting chain and the wetting of mine cars in transit.

This prevents coal-dust getting into the air and being distributed, which requires more rock-dust to neutralize. Thus the danger is decreased and the cost of preventing coal-dust explosions lessened.

Enormous Cube Represents 1927 Production

A CUBE nearly twice as high as the Washington monument could be formed by the crushed stone produced in the United States in 1927, the Bureau of Mines of the Department of Commerce stated November 15. The statement follows in full text:

It is a safe assertion that few people in the United States have a very definite conception of the enormous amounts of crushed stone produced annually in the country. According to a recent announcement by the Bureau 95,000,000 short tons of crushed stone were produced by the nation in 1927.

This quantity of crushed stone, considering that the rock weighs 165 pounds to a cubic foot, would mean a cube of solid rock about 1,050 feet, or 1-5 of a mile on an edge—that is, a cube whose edge is almost twice as high as the Washington Monument or 1½ times as tall as the Woolworth Building. If it were made into a mass 10 feet square, it would reach approximately 2,200 miles, or about the distance from Chicago to San Francisco.

It would make an automobile road composed of a solid sheet of rock 20 feet wide and one foot thick which would reach from the most northern coast of North America to the South Pole. If it were made into a single piece one foot square, it would reach around the globe almost nine times. In other words, it would make a stone sidewalk almost nine feet wide and one foot thick the entire distance around the earth at the equator. To be crushed during the year, this sidewalk would have to be fed into an enormous crusher about as fast as a man walks, or at the rate of about 260 feet per minute, a mile every 20 minutes, night and day, holidays and Sundays.

The Crushed Stone Journal

J. R. BOYD, Editor

A. T. GOLDBECK, Director, Bureau of Engineering

The National Crushed Stone Association

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Research Laboratory Completes First Investigation

THE publication in this issue of the Journal of the first test results available from the Association's research testing laboratory given in the article by Mr. Goldbeck entitled, "The Effect of Gradation of Crushed Stone on Percentage of Voids," should be of more than passing interest, marking, as it does, the accomplishment of one more step in the Association's efforts to actively and effectively promote the interests of the industry. The Research Laboratory about which so much has been said during the past year is no longer an idea, but has become a definite, specific agency for the advancement of the welfare of the industry, thus bringing to realization the purpose for which it was established.

Regarding the nature of the tests made in this first investigation, it should be of interest to know that the Bureau of Engineering felt many months ago that the Bureau of Public Roads would advocate, "the scientific grading of coarse aggregate by combination of separate sizes in each batch in the proportions which will produce maximum practicable density" as announced elsewhere in this issue, and in anticipation of the time when such a policy would be publicly advocated this series of investigations was undertaken in order that the stone producer would not be taken unawares, but would have information which would be of invaluable assistance to him in cooperating with the users of crushed stone in providing material sized in accordance with this policy.

A number of other investigations dealing with a variety of subjects are in course of completion the results of which will be published in forthcoming issues of the Journal.

Bureau of Mines Cost Data Investigation

AT the last annual convention of this Association, Mr. J. R. Thoenen of the Bureau of Mines, explained a questionnaire which he proposed to send out to crushed stone producers for the purpose of obtaining data on the cost of the various operations in crushed stone production. The convention went on record as in favor of the Bureau of Mines proposal and up to the present time Mr. Thoenen has received returns from his questionnaire representing approximately 10½ per cent of the tonnage of the National Crushed Stone Association. Thirty-eight per cent of the members of the Association have replied, but only 20 per cent have given cost figures. These records indicate that our members either have not fully grasped the value of the figures which the Bureau of Mines is compiling for them or they have been too busy to fill out the lengthy questionnaire which they received from the Bureau.

We have had the privilege of examining the tabulations which Mr. Thoenen has made of the figures thus far received. These tabulations are grouped in such a way that general comparisons may very readily be made of the various items of cost involved in the production of crushed stone but in no case are the costs of an individual quarry given. The tables answer many questions in which stone producers are vitally interested and a study of them should most certainly indicate to every producer whether certain items of his costs may not be materially reduced.

Unlike other figures which have been put forward on cost of production, overhead has been included, thus giving a true idea of the actual cost of stone production. We feel that the work which the Bureau of Mines is doing in the analysis of costs, as they are influenced by the many variables entering into the production of crushed stone, are exceedingly valuable to the industry and the more replies received the more accurate will be the final results.

We hope that every member company of the Association, which has not thus far filled out the cost data questionnaire will do so and return it to the Bureau of Mines as promptly as possible for we firmly believe that the value of the results to the industry will warrant the time and trouble required to furnish the desired information.

The Value of a Research Laboratory

DOES a research laboratory have a practical value to the manufacturer? Is it of assistance in reducing costs and increasing profits, or is it but a passing fad, helpful of course to some extent, but of no particular assistance in solving the every day problems of plant and sales office?

The answers to these questions and many more related ones have recently been obtained through a survey made under the supervision of Maurice Holland by the Division of Engineering and Industrial Research of the National Research Council.

The following represents a very brief digest of some of the more interesting facts brought out by the survey.

"Out of 800 replies received from manufacturers, 797 indicate their belief that research pays.

"In addition to research by Government bureaus, educational institutions, trade associations, and special groups in an industry cooperating on a definite research job, 68 per cent of these manufacturers maintain private laboratories. Over one-third of these are working to improve the quality of products and service to customers, on the assumption that reduced production costs will follow; 25 per cent of them towards the development of new fields of application; and 15 per cent to discover by-products and new materials.

"Returns from leading manufacturers indicate that, excluding the automobile industry, on which figures are incomplete, the highest average annual research expenditures are $105,000, in the chemical and allied products industry, followed by $100,000 in the rubber and rubber products industry. The average research expenditures in percentage of capital invested are 2.4 for the chemicals and allied products industry, with metal working plants holding second place with 2.1. Research expenditures by metal working plants showed an increase of 200 per cent for 1927 over 1926, while a 100 per cent increase was reported for the paper and pulp, rubber and rubber products, and textile industries."

The crushed stone industry can well take pride in the fact that, through its official organization, the National Crushed Stone Association, there was established during the past year an excellently equipped research testing laboratory, thus permitting our industry to take its rightful place among those who recognize the value of research to industry. And while we quite properly take pride in the accomplishment of this forward-looking step, let us not at the same time be unmindful of the necessity of providing adequate revenue for its continued and successful operation.

In this connection some of the figures above should be of decided interest. The chemicals and allied products industry makes an annual average expenditure for research of 2.4 per cent on the basis of the capital invested, followed by the metal working plants with 2.1 per cent.

President Graves in his address before the West Baden Convention stated that the crushed stone industry has a total capital invested of approximately $250,000,000. Many of the leading industries of the country have demonstrated to themselves beyond the shadow of a doubt the vital necessity and dollars and cents value of expending funds sufficiently large to insure the carrying on of adequate and extensive research programs. The crushed stone industry is confronted with a similar necessity at the present time. Now that we have our research testing laboratory, what are we going to with it? The answer is obvious. Sufficient funds must be provided for its adequate maintenance and operation to the end that it may function to the best interests of the industry.

On the basis of capital invested, a fund equivalent to one one-hundredth of one per cent would yield approximately $25,000 which may seem to be an ambitious figure. On the other hand it does not seem unreasonable to ask an industry with a capital invested of $250,000,000 to expend annually $25,000 for the carrying on of research investigations which are vitally necessary if it is to hold its own with competing materials.

Gas Association Establishes Second Laboratory

AMONG the associations recognizing the value of a testing laboratory is the American Gas Association, which recently dedicated its second such laboratory.

In dedicating the laboratory, Oscar H. Fogg, President of the Association said:

> "The laboratory is in no sense a commercial enterprise. It is a tangible expression of the industry's allegiance to the principle that its greatest progress will be made through providing the best possible service to the American people."

In the two and a half years of the old laboratory's existence, it tested some 11,000 gas appliances and made beneficial suggestions for 98 per cent of these appliances. This is an excellent commentary on the service of the laboratory to trade associations.

The new laboratory of the gas association is said to be the most completely equipped gas appliance and research laboratory anywhere. The building has a few rooms equipped for the personal use of any of the more than 200 manufacturers served by the Association's laboratory.—*Nation's Business.*

New York Producers and Manufacturers' Division Meet at New York

(*Continued from page 9*)

self-government of their own selection, to correct a large number of vexations and long standing trade abuses.

"More and stronger trade associations, organized under proper conditions and with adequate safeguards, are foreshadowed by all these recent developments.

"Whatever will facilitate a closer adaptation of production and distribution to the requirements of demand will serve to bring under human control one of the most baleful causes of human unhappiness.

"Overproduction, business depression and unemployment, it is now realized, are comparable only to disease in the devastating and far-reaching injuries they inflict upon the morale and well being of the entire nation.

"Trade associations, if they will utilize these opportunities for business self-government, can raise American business to a level of achievement exceeding anything that has yet been dreamed of."

Otho M. Graves, President of the National Association and A. T. Goldbeck, Director of the Bureau of Engineering, also gave short talks at the luncheon emphasizing the progress which is being made by the new research laboratory of the Association.

Engineering Bulletin No. 6

ENGINEERING Bulletin No. 6, entitled, "The Bituminous Macadam Pavement," by A. T. Goldbeck, Director, Bureau of Engineering, has just recently been completed and sent to our membership.

This bulletin discusses in detail the bituminous macadam pavement and should be exceedingly valuable in stimulating the increased use of crushed stone in this important type of construction. In the introduction of the bulletin Mr. Goldbeck comments as follows:

"Although the merits and usefulness of bituminous macadam pavement are well known in many localities, they are not yet fully realized in others. It is a comparatively new type of construction and was developed to produce a road surfacing which would not ravel under automobile traffic and which would be dustless. When properly designed and carefully constructed, it is an excellent pavement, well fitted for the needs of present-day traffic. Its use is growing on our principal highway systems and it has become so important that earnest effort should be devoted to its highest development and to a wide dissemination of information on the best methods for its construction. It is the aim of the present article to give helpful facts to those interested in bituminous macadam pavements."

For the convenience of our members in ordering Bulletin No. 6, there was attached to each copy an order blank and self-addressed return envelope. The membership should take immediate advantage of this timely bulletin and of the opportunity which it affords of distributing within their respective territories this very valuable and useful information. We earnestly suggest that you give this matter your immediate attention and forward your order to the Washington office at once.

Twenty-Seven Thousand Tons of Crushed Stone Used In Constructing Landing Field

WRITING in the September issue of The Crushed Stone Journal, Mr. Goldbeck, director of the Bureau of Engineering, pointed out that future construction of airports and landing fields offered a very large potential market for crushed stone and it is therefore particularly interesting to note that in the construction of the Donald Woodward Airport, recently completed at LeRoy, New York, a surprisingly large tonnage of crushed stone was used.

The airport itself represents an investment of over $500,000. Pilots are enabled to take off or land in any prevailing wind by means of fine macadam runways, 100 feet wide and averaging 3,000 feet in length. The runways are three feet thick and required approximately 27,000 tons of crushed stone for their construction.

From the remarkably large tonnage of crushed stone used in the building of this landing field it would seem that this class of construction offers a potential market that will be very much worth while.

Bulletin 1216 Revised

BULLETIN 1216 of the United States Department of Agriculture, entitled, "Tentative Standard Methods of Sampling and Testing Highway Materials," has been revised as of September, 1928, and additional copies may be procured from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., at thity cents per copy.

It will be remembered that Bulletin 1216 gives the methods of sampling and testing of highway materials used in Federal-Aid Road Construction and as such should be of considerable interest to crushed stone producers.

National Crushed Stone Association

Twelfth Annual Convention

Hollenden Hotel -- Cleveland, Ohio

January 21, 22, 23 and 24, 1929

Make Your Hotel Reservations Immediately

Hotel Reservations for the forthcoming convention of the crushed stone industry should be made immediately by applying direct to Mr. Theo. DeWitt, Manager of the Hollenden Hotel, Cleveland. By attending to this matter today you will be assured of having just the accomodations desired.

REMEMBER

All crushed stone producers of the United States and Canada, whether or not members of this Association, are most cordially invited to be present at Cleveland and share with us the many benefits and pleasures of the Convention.

For Further Information Apply to

National Crushed Stone Association

Merchandise Building Fourteenth and S Streets Washington, D. C.